Appendix G – Conceptual Stormwater Management Plan

Conceptual Stormwater Management Plan

Introduction

This memorandum describes the existing drainage system at the Bow Lake Transfer Station, identifies design criteria and regulatory requirements, and presents a conceptual stormwater management system that would be used to control and treat stormwater at the site. For the purpose of this memorandum, "site" refers to the area within the limits of the proposed Bow Lake recycling and transfer station improvements project boundary. The site is located along the east side of Interstate 5, just north of the intersection of Orillia Road and South 188th Street. The majority of the site is located within the City of Tukwila (the City). A small portion is located in unincorporated King County. The total site area is approximately 12 acres, 4.4 of which will be new impervious surface. Site improvements include demolition of all existing on site facilities and construction of two scale facilities, a new transfer building, recycling areas, and other equipment and operator facilities. The surface water management facilities required for these improvements include:

- Stormwater quantity control (detention facilities),
- Stormwater quality control facilities,
- Conveyance system including piping, curb and gutter and or ditches,
- Temporary erosion and sediment control and water quality source control during construction,
- Permanent water quality source controls.

This memorandum is divided into three sections: 1) a description of the existing affected environment in the vicinity of the project site and the downstream system, 2) a description of stormwater control design criteria and regulatory requirements, 3) a description of the conceptual design of stormwater management and impact mitigation facilities.

Existing Drainage System

The existing Bow Lake Transfer Station was built almost 30 years ago on the site of a closed landfill. The area immediately north of the existing Transfer Station site is mostly undeveloped and is owned by WSDOT. This area consists of a large 30-foot high mound of fill. The area closest to Interstate 5 is used by WSDOT as a construction laydown yard for work along the freeway. The site is generally flat in the area of the existing facilities with a steep down slope to the east. Most of the runoff generated at the existing site drains to one of approximately four storm drains that discharge to a steep slope to the east on the eastern part of the site. Flow from certain areas where runoff has a greater potential to come into contact with solid waste operations, including the trailer parking

area, drain to a vault, which is pumped out and trucked off site. The steep hill slope to the east contains natural drainage swales that eventually convey the runoff to South Center Parkway, approximately 700 feet east of the Transfer Station.

Downstream Drainage System

Runoff that leaves the site discharges to an existing ditch and culvert system along South Center Parkway that routes flow to the north. This drainage basin is known as the North Basin. Flow from this system is conveyed to a system in SW 43rd street and is eventually discharged into the Green River at the P17 pump station. Based on conversations with the City, there are no known drainage problems downstream of the transfer station site.

A private developer has proposed a plan to improve and possibly realign South Center Parkway in the vicinity of this project. Although there are no approved plans, the City anticipates that the project will move forward over the next several years. These changes could affect the downstream drainage system in the future (i.e., the storm drainage would likely be converted from a ditch and culvert system to a piped system). The County has initiated discussions with the City to coordinate with the South Center Parkway improvement project. If the project is constructed prior to the Bow Lake improvement project, provisions should be made for connecting to the new system. For example, the parkway improvements could include a drainage stub to allow the transfer station to tie directly to the roadway drainage system without having to disturb the newly constructed street.

Hydrologic Analysis of Existing Conditions

A hydrologic KCRTS model was developed to estimate existing runoff rates from the site. A summary of the analysis follows in Table 1. Model output is included in Appendix A. Although some of the impervious area at the existing site is conveyed to the sanitary sewer system, to be conservative, it was assumed that all runoff enters the storm drain system.

Table 1

Hydrologic Results – Existing Conditions

Impervious Area (acres)	4.34
Till Grass Area (acres)	2.50
Till Forest Area (acres)	4.70
Total Area (acres)	11.54
Peak Flow (cfs)	
2-year	2.27
10-year	4.11
25-year	5.62
100-year	8.86

Design Criteria and Regulatory Requirements

The regulatory requirements governing this project were reviewed to determine the likely design criteria that would be required for the project. The applications for permits for this project would likely be submitted sometime in late 2007. This section identifies permits that will likely be required for the project and describes the design criteria used to develop the conceptual stormwater management system and the required stormwater controls during construction.

Federal, state and local agencies may require permits for work related to stormwater associated with the transfer station improvements. Federal permits may include a Section 404 Permit from the U.S. Army Corps of Engineers (USACE), a Section 7 Endangered Species Act Consultation with NOAA Fisheries (NMFS) and U.S. Fish and Wildlife Service (USFWS) for potential impacts to jurisdictional wetlands. A National Pollutant Discharge Elimination System (NPDES) permit, which would include a Stormwater Pollution Prevention Plan will likely be required by the State Department of Ecology for construction activities including clearing, grading and excavation.

Per Tukwila Municipal code 14.30.070, the City has adopted the 1998 *King County Surface Water Design Manual* (KCSWDM, or Manual) except as amended by the City of Tukwila Public Works Development Guidelines and Design and Construction Standards. The City is currently considering adopting the 2005 Manual and will likely do so in 2006. Because it is likely that the City will have adopted the 2005 Manual prior to submission of permit applications for the Bow Lake Transfer Station Improvement project, surface water facilities will be designed to follow the 2005 Manual guidelines and requirements.

The 2005 Manual uses thresholds to define the type of drainage review required for different sizes and types of projects. The type of drainage review generally defines which requirements apply. The manual applies eight "Core Requirements" plus "Special Requirements". Core Requirements apply to all projects meeting certain thresholds. Special Requirements also apply depending on the project location or site specific characteristics.

The Bow Lake Transfer Station project will create more than 2,000 square feet of new impervious surface and does not qualify for a Small Drainage review (not an agricultural or single family residential project) and therefore will require a Full Drainage Review. As such, it will be required to meet all eight of the Core Requirements as follows:

1. **Discharging surface water at the natural location**. Natural drainage patterns are to be maintained and discharges from the project site shall occur at the natural locations, to the maximum extent practicable.
2. **Providing an off-site analysis**. All projects must submit an offsite analysis report that assesses potential offsite drainage impacts associated with development of the project site and propose appropriate mitigation of those impacts. The objective of the requirement is to identify and evaluate offsite drainage problems that may be created or aggravated by the proposed project and to determine appropriate measures for preventing aggravation of those projects.
3. **Providing flow control.** All projects, including redevelopment projects such as the Transfer Station Improvement Project, must provide onsite flow control facilities or flow control BMPs or both to mitigate the impacts of storm and surface water runoff

generated by new impervious surface, new pervious surface and replaced impervious surface. The transfer station project is within a "Basic Flow Control" area and requires detention such that outflows match the 2-and 10-year flows for existing conditions.

4. **Providing a conveyance system.** All engineered conveyance system elements for projects must be analyzed, designed and constructed to provide a minimal level of protection against overtopping, flooding, erosion, and structural failure. The conveyance system will be sized to handle 25-year peak flows calculated using 15-minute time steps in the King County Backwater Model (KCBW).
5. **Providing erosion and sediment control measures**. All projects that will clear, grade, or otherwise disturb the site must provide erosion and sediment controls to prevent, to the maximum extent practicable, the transportation of sediment and other construction–related pollutants from the project site to downstream drainage facilities, water resources, and adjacent properties.
6. **Maintaining and operating the surface water facilities**. The objective of this requirement is to ensure that the drainage facilities will be properly maintained and operated in perpetuity.
7. **Complying with financial guarantees**. Project proponents must comply with the financial guarantee requirements in King County Ordinance 12020 and the liability requirements of King County Code 9.04.100. The objective is to ensure that financial guarantees are posted to sufficiently cover the cost of correcting, if necessary, incomplete or substandard drainage facility construction. It is also intended to ensure that a liability policy is provided which protects proponent and the County from any damages relating to the construction or maintenance of required drainage facilities by private parties. In adopting the KCSWDM, the City of Tukwila will likely modify this requirement to its own municipal guarantee requirements.
8. **Providing water quality treatment.** All projects, including redevelopment projects, must provide water quality facilities to treat the runoff from those new and replaced pollution-generating impervious surfaces and new pollution-generating pervious surfaces targeted for treatment. The Bow Lake Transfer station will qualify as a "Basic Water Quality Area" and therefore the goal of treatment is to remove 80% of total suspended solids (TSS). The water quality treatment flow upstream of detention is 60% of the developed 2-year peak flow as determined using the KCRTS model. Downstream of detention, the water quality treatment flow is the full 2-year release rate. The water quality treatment volume is a minimum of 95% of the average annual runoff volume in the time series as determined by the KCRTS model.

In addition to the Core Requirements, the project will be required to meet all applicable Special Requirements. Of the Special Requirements, the only one that applies is Special Requirement 4, Source Controls. This requirement is triggered because the project will require a commercial site development permit. Water quality source controls will be required to prevent rainfall and runoff water from coming into contact with pollutants, thereby reducing the likelihood that pollutants will enter public waterways and violate water quality standards.

Projects subject to a Full Drainage Review are required to have a Technical Information Report (TIR), prepared by a professional engineer. The TIR will include the drainage design plus supporting calculations as well as the proposed erosion and sediment control plan (ESC).

In addition to meeting the local requirements in the 2005 Manual, an NPDES permit for construction will also be required. These permits, which are administered by the Department of Ecology, are required for projects that will create land disturbing activities in excess of 1 acre. For this permit a Storm Water Pollution Prevention Plan (SWPPP) must be prepared. Most of the requirements of the SWPPP are similar to the requirements of the Full Drainage Review.

The Green River Flood Control Zone District is a quasi-municipal corporation of the State of Washington that is primarily responsible for maintaining and operating flood protection facilities on the lower Green River within its boundaries. Discharges to the Green River in the Cities of Auburn, Kent, Renton, and Tukwila and in King County are regulated by the Green River Pump Operations Procedures Plan. The plan establishes guidelines for the design and operation of pumped and gravity outfalls to the Green River. Flood protection measures include limiting pump station operating hours and providing storage for the 100-year 7-day rainfall event. Because stormwater from the Bow Lake facility will be conveyed to an existing pump station, the requirements of this document do not apply.

Conceptual Stormwater Management Design and Mitigation Approach

This section describes a conceptual level approach for providing a drainage system for the proposed Transfer Station that meets the 2005 KCSWDM requirements. To meet the core requirements, the project will include both permanent storm water facilities as well as temporary measures for erosion and sediment control during construction. The permanent storm drainage system will include piping, detention vaults and stormwater quality treatment. A conceptual layout of the permanent facilities is shown in Figure 1.

Mitigation during Construction

The Bow Lake Transfer station will be constructed in phases. Throughout construction, temporary drainage and erosion control facilities and source controls will be provided. Erosion and sediment control measures may include:

- Providing temporary cover over exposed soils and stockpiles,
- Using silt fencing between construction activities and downstream water courses,
- Installing check dams along existing and temporary ditches,
- Directing runoff to temporary sediment traps or portable treatment tanks for treatment prior to discharge to the downstream system,
- Preventing track off of sediment onto offsite roadways,
- Install permanent cover measures as soon as possible after construction is complete.

Water quality source controls would also be required during construction to prevent pollutants from coming into contact with stormwater. Source control measures could include:

- Safe handling of petroleum products including proper storage and maintenance of vehicles and equipment.
- Isolating areas with higher potential for pollution and conveying runoff from these areas to the sanitary sewer system.

Permanent Facilities

Hydrologic Analysis of Developed Conditions

The KCRTS model was used to evaluate the potential increase in runoff from the recycling and transfer station development at the Bow Lake site. The hydrologic model was used to estimate future runoff rates for the improved site conditions. Table 2 provides a summary of model input and results. Note that 0.45 acres of impervious area will be diverted from the storm drain system to the sanitary sewer.

Table 2

Hydrologic Results – Developed Conditions

Impervious Area (acres)	8.78
Till Grass Area (acres)	2.32
Diverted to Sanitary Sewer (acres)	0.45
Total Area (acres)	11.54
Peak Flow (cfs)	
2-year	4.38
10-year	7.48
25-year	9.72
100-year	14.13

Conveyance

Conceptual conveyance systems for the Bow Lake Transfer Station are shown schematically on Figure 1. All paved surfaces including building roofs will be conveyed by 12-24-inch-diameter storm drain pipes. These pipe sizes are preliminary and will be confirmed by detailed hydraulic analysis during final design. The conveyance system will collect runoff from the site and direct it to an underground detention vault. Detained flows would discharge to a water quality treatment system then be piped down the eastern slope via a 24-inch-diameter butt-fussed HDPE pipe. The treated runoff would be discharged to "Stream E" either directly or by first connecting to the existing drainage system along Southcenter Parkway. Piping the flows down the slope will help mitigate any concern about erosion of the hillside. Doing so will require an easement from the property owner adjacent to the project site.

Detention Facilities

A vault was selected to detain runoff rather than an open pond or infiltration facility due to unsuitable soils and the lack of space available to provide an open pond. Per the City of Tukwila Public Works Development Guidelines and Design and Construction Standards, the site is within a "Basic Flow Control Area" and therefore, the Level 1 flow control standard applies, which requires matches the existing site conditions 2- and 10-year peak flows.

To size the detention facilities, the Manual requires the use of King County Runoff Time Series hydrologic model (KCRTS). Preliminary sizing suggests that an 18'x50'x11' vault will be required to meet Level 1 flow control requirements. Release of stormwater from the vault will be controlled with a multiple orifice outlet control structure.

Water Quality Treatment Facilities

The transfer station is located outside the drainage basin of sensitive lakes or sphagnum bog wetlands and therefore only requires basic water quality treatment. The Manual offers several different types of water quality treatment BMPs from a menu for selection as appropriate for the site conditions. Bioswales and wetponds are not feasible at the site due to lack of room for such facilities. Wet vaults within the detention vaults were another possibility considered, but were rejected because they would increase the depth of the vaults by at least 3 feet and would require a vault length-to-width ratio that would make them difficult to fit on the site. Water quality treatment at the Transfer Station will be provided by StormFilter systems. A StormFilter system is a media filtration system that consists of media-filled cartridges that can be installed in a manhole or vault depending on the number of cartridges required to treat the flow. The StormFilter cartridges can be filled with an array of media, selected to treat the specific pollutant loadings at each site. Since this site is only required to provide basic treatment, the media would be selected primarily to remove sediment. As shown on Figure 1, The StormFilters will be located on the downstream side of the detention facility in order to reduce their required size. The systems typically require 2.3 feet of head differential between the inlet and the outlet. The StormFilter cartridges for the Transfer Station site will need to be contained in vaults due to the number of anticipated filter cartridges required. Sizing of the vaults will be done as part of final design.

Additional water quality measures will be considered for areas with higher potential for pollution. As a method of source control, areas close to Transfer Station operations including full trailer parking pads and the fee recycling area (but not the free recycling area) will be isolated and the storm water will either be routed to the storm or sanitary sewer system depending on conditions. Although not required by the Manual, the trailer parking area, scale facility area, and queuing areas will be drained to a coalescing plate oil/water separator for additional treatment prior to release to the site drainage system. These areas are indicated on Figure 1.

Although the final facility plan may include harvesting of rainwater from the transfer station roof for use within the building, to be conservative the conceptual drainage plan assumes that roof runoff will collected and treated. The roofs of the new buildings at the proposed transfer station will likely be coated such that they will not be pollution-

generating surfaces, and therefore the roof runoff would not require treatment. However, because the runoff from the roofs is required to be detained, it will also be treated for water quality. This is because it is not practical to separate the roof runoff from the flow from the rest of the site after it has been combined in the detention facility. Separate detention facilities could be provided to keep the roof runoff separate from the rest of the site, but the cost of providing separate detention facilities would likely out weigh the savings provided by not routing the roof runoff to the water quality treatment facility.

APPENDIX A

Hydrologic Modeling Results

Bow Lake Transfer Station
Preferred Site Plan
Land Use
5/1/2006

	Existing	Developed
Forest	4.7	0
Grass	2.5	2.32
Impervious	4.34	8.78
Sewer	0	0.45

PRE-DEVELOPED PEAK FLOWS

11-BLPreDev.pks

Flow Frequency Analysis
Time Series File:11-blpredev.tsf
Project Location:Sea-Tac

LogPearson III Coefficients
Mean= 0.396 StdDev= 0.164
Skew= 1.556

---Annual Peak Flow Rates--- Flow Rate (CFS)	Rank	Time of Peak
3.45	9	2/16/49 17:45
4.82	4	3/03/50 15:00
2.03	35	8/27/51 18:00
2.31	28	10/17/51 7:15
1.70	44	9/30/53 3:00
1.97	38	12/19/53 17:30
1.66	46	7/30/55 21:15
2.50	19	10/04/55 10:00
2.38	24	12/09/56 12:45
2.21	33	1/16/58 10:00
2.76	13	10/18/58 19:45
2.74	14	10/10/59 22:00
2.40	22	2/14/61 20:15
2.00	36	8/04/62 13:15
1.95	39	12/01/62 20:15
1.52	49	6/05/64 15:00
2.23	30	4/20/65 19:30
1.55	48	1/05/66 15:00
2.51	18	11/13/66 17:45
5.06	3	8/24/68 15:00
2.27	29	10/20/68 12:00
1.42	50	1/13/70 20:45
1.72	43	12/06/70 7:00
3.58	7	12/08/71 17:15
1.99	37	4/18/73 9:30
2.38	26	11/28/73 8:00
2.59	17	8/17/75 23:00
1.76	42	10/29/75 7:00
1.63	47	8/23/77 14:30
2.88	11	9/17/78 1:00
3.96	6	9/08/79 13:45
2.80	12	12/14/79 20:00
2.70	15	9/21/81 8:00
5.63	2	10/05/81 22:15
2.36	27	10/28/82 16:00
1.86	40	1/02/84 23:30
1.68	45	6/06/85 21:15
2.49	20	10/27/85 10:45
2.92	10	10/25/86 22:45
2.38	25	5/13/88 17:30
2.21	32	8/21/89 16:00
3.48	8	1/09/90 5:30
2.40	23	4/03/91 20:15
1.86	41	1/27/92 15:00
2.22	31	6/09/93 12:15
2.11	34	11/17/93 16:45
2.49	21	6/05/95 17:00
2.63	16	7/19/96 19:30
10.79	1	12/29/96 11:45
4.58	5	10/04/97 14:15
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		

-----Flow Frequency Analysis------- - - Peaks - - (CFS)	Rank	Return Period	Prob
10.79	1	89.50	0.989
5.63	2	32.13	0.969
5.06	3	19.58	0.949
4.82	4	14.08	0.929
4.58	5	10.99	0.909
3.96	6	9.01	0.889
3.58	7	7.64	0.869
3.48	8	6.63	0.849
3.45	9	5.86	0.829
2.92	10	5.24	0.809
2.88	11	4.75	0.789
2.80	12	4.34	0.769
2.76	13	3.99	0.749
2.74	14	3.70	0.729
2.70	15	3.44	0.709
2.63	16	3.22	0.690
2.59	17	3.03	0.670
2.51	18	2.85	0.650
2.50	19	2.70	0.630
2.49	20	2.56	0.610
2.49	21	2.44	0.590
2.40	22	2.32	0.570
2.40	23	2.22	0.550
2.38	24	2.13	0.530
2.38	25	2.04	0.510
2.38	26	1.96	0.490
2.36	27	1.89	0.470
2.31	28	1.82	0.450
2.27	29	1.75	0.430
2.23	30	1.70	0.410
2.22	31	1.64	0.390
2.21	32	1.59	0.370
2.21	33	1.54	0.350
2.11	34	1.49	0.330
2.03	35	1.45	0.310
2.00	36	1.41	0.291
1.99	37	1.37	0.271
1.97	38	1.33	0.251
1.95	39	1.30	0.231
1.86	40	1.27	0.211
1.86	41	1.24	0.191
1.76	42	1.21	0.171
1.72	43	1.18	0.151
1.70	44	1.15	0.131
1.68	45	1.12	0.111
1.66	46	1.10	0.091
1.63	47	1.08	0.071
1.55	48	1.05	0.051
1.52	49	1.03	0.031
1.42	50	1.01	0.011
8.86		100.00	0.990
7.07		50.00	0.980
5.62		25.00	0.960
4.11		10.00	0.900
3.87		8.00	0.875
3.22		5.00	0.800
2.27		2.00	0.500
1.87		1.30	0.231

MATCH 2&10 for Level 1 Flow Control

DEVELOPED PEAK FLOWS

Flow Frequency Analysis
Time Series File:11-bldev.tsf
Project Location:Sea-Tac

11-BLDev.pks
LogPearson III Coefficients
Mean= 0.672 StdDev= 0.151
Skew= 1.243

---Annual Peak Flow Rates--- Flow Rate (CFS)	Rank	Time of Peak
6.12	8	2/16/49 17:45
7.87	6	3/03/50 15:00
4.11	32	8/27/51 18:00
4.44	25	10/17/51 7:15
3.37	42	9/30/53 3:00
3.66	38	12/19/53 17:30
3.35	43	7/30/55 21:15
5.05	17	10/04/55 10:00
4.19	31	10/19/56 23:45
4.02	35	1/16/58 10:00
5.43	13	10/18/58 19:45
5.23	16	10/10/59 22:00
4.31	28	2/14/61 20:15
4.05	34	8/04/62 13:15
3.63	39	12/01/62 20:15
3.06	48	6/05/64 15:00
3.97	36	4/20/65 19:30
2.89	49	9/17/66 17:45
4.76	22	11/13/66 17:45
9.45	3	8/24/68 15:00
4.33	27	10/20/68 12:00
2.63	50	5/29/70 7:45
3.12	47	12/06/70 7:00
6.25	7	12/08/71 17:15
3.96	37	4/18/73 9:30
4.43	26	11/28/73 8:00
5.24	15	8/17/75 23:00
3.30	44	10/29/75 7:00
3.29	45	8/23/77 14:30
5.71	11	9/17/78 1:00
7.92	5	9/08/79 13:45
5.03	18	12/14/79 20:00
5.45	12	9/21/81 8:00
10.32	2	10/05/81 22:15
4.57	23	10/28/82 16:00
3.47	40	1/02/84 23:30
3.28	46	6/06/85 19:15
4.82	20	10/27/85 10:45
5.77	9	10/25/86 22:45
4.81	21	5/13/88 17:30
4.48	24	8/21/89 16:00
5.72	10	1/09/90 5:00
4.31	29	4/03/91 20:15
3.42	41	1/27/92 15:00
4.11	33	6/09/93 12:15
4.26	30	11/17/93 16:45
4.99	19	6/05/95 17:00
5.31	14	7/19/96 19:30
16.10	1	12/29/96 11:45
8.25	4	10/04/97 14:15
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		
Computed Peaks		

-----Flow Frequency Analysis------- - - Peaks - - (CFS)	Rank	Return Period	Prob
16.10	1	89.50	0.989
10.32	2	32.13	0.969
9.45	3	19.58	0.949
8.25	4	14.08	0.929
7.92	5	10.99	0.909
7.87	6	9.01	0.889
6.25	7	7.64	0.869
6.12	8	6.63	0.849
5.77	9	5.86	0.829
5.72	10	5.24	0.809
5.71	11	4.75	0.789
5.45	12	4.34	0.769
5.43	13	3.99	0.749
5.31	14	3.70	0.729
5.24	15	3.44	0.709
5.23	16	3.22	0.690
5.05	17	3.03	0.670
5.03	18	2.85	0.650
4.99	19	2.70	0.630
4.82	20	2.56	0.610
4.81	21	2.44	0.590
4.76	22	2.32	0.570
4.57	23	2.22	0.550
4.48	24	2.13	0.530
4.44	25	2.04	0.510
4.43	26	1.96	0.490
4.33	27	1.89	0.470
4.31	28	1.82	0.450
4.31	29	1.75	0.430
4.26	30	1.70	0.410
4.19	31	1.64	0.390
4.11	32	1.59	0.370
4.11	33	1.54	0.350
4.05	34	1.49	0.330
4.02	35	1.45	0.310
3.97	36	1.41	0.291
3.96	37	1.37	0.271
3.66	38	1.33	0.251
3.63	39	1.30	0.231
3.47	40	1.27	0.211
3.42	41	1.24	0.191
3.37	42	1.21	0.171
3.35	43	1.18	0.151
3.30	44	1.15	0.131
3.29	45	1.12	0.111
3.28	46	1.10	0.091
3.12	47	1.08	0.071
3.06	48	1.05	0.051
2.89	49	1.03	0.031
2.63	50	1.01	0.011
14.13		100.00	0.990
11.75		50.00	0.980
9.72		25.00	0.960
7.48		10.00	0.900
7.09		8.00	0.875
6.05		5.00	0.800
4.38		2.00	0.500
3.59		1.30	0.231

VAULT DISCHARGE PEAKS.

rdout.pks

Flow Frequency Analysis
Time Series File:rdout.tsf
Project Location:Sea-Tac

LogPearson III Coefficients
Mean= 0.435 StdDev= 0.171
Skew= 1.921

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------				
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	(ft)	Rank	Return Period	Prob
3.12	13	2/16/49 18:00	13.88	9.19	1	89.50	0.989
5.57	3	3/03/50 15:30	6.10	8.25	2	32.13	0.969
2.22	33	2/09/51 1:30	5.57	8.21	3	19.58	0.949
1.86	49	10/15/51 12:15	5.50	8.20	4	14.08	0.929
2.04	39	9/30/53 3:45	5.39	8.19	5	10.99	0.909
2.23	30	12/19/53 18:00	4.11	8.00	6	9.01	0.889
2.23	31	11/25/54 1:15	3.93	7.61	7	7.64	0.869
2.27	26	11/18/55 15:15	3.85	7.44	8	6.63	0.849
3.23	12	12/09/56 13:00	3.60	6.93	9	5.86	0.829
2.31	24	12/25/57 15:15	3.53	6.80	10	5.24	0.809
2.08	36	10/18/58 20:00	3.43	6.64	11	4.75	0.789
2.23	32	11/20/59 3:45	3.23	6.30	12	4.34	0.769
2.04	38	2/14/61 20:30	3.12	6.15	13	3.99	0.749
2.13	34	8/04/62 13:45	3.10	6.13	14	3.70	0.729
2.02	40	12/15/62 1:30	3.02	6.02	15	3.44	0.709
2.25	27	12/31/63 22:15	3.01	6.00	16	3.22	0.690
2.00	43	4/20/65 19:45	3.00	5.99	17	3.03	0.670
1.89	48	1/05/66 15:15	2.92	5.89	18	2.85	0.650
3.53	10	11/13/66 18:00	2.91	5.88	19	2.70	0.630
5.39	5	8/24/68 15:15	2.83	5.84	20	2.56	0.610
2.24	29	12/03/68 15:45	2.81	5.84	21	2.44	0.590
2.01	41	1/13/70 21:45	2.48	5.70	22	2.32	0.570
1.98	44	12/05/70 8:45	2.47	5.69	23	2.22	0.550
3.43	11	12/08/71 17:30	2.31	5.42	24	2.13	0.530
2.06	37	6/24/73 12:45	2.28	5.29	25	2.04	0.510
2.48	22	11/28/73 8:30	2.27	5.23	26	1.96	0.490
2.92	18	12/26/74 22:15	2.25	5.14	27	1.89	0.470
1.77	50	12/02/75 19:30	2.24	5.12	28	1.82	0.450
2.24	28	8/26/77 1:15	2.24	5.10	29	1.75	0.430
3.93	7	9/17/78 1:15	2.23	5.07	30	1.70	0.410
3.85	8	9/08/79 14:00	2.23	5.07	31	1.64	0.390
3.10	14	12/14/79 20:15	2.23	5.07	32	1.59	0.370
2.83	20	11/21/80 10:30	2.22	5.04	33	1.54	0.350
6.10	2	10/06/81 14:15	2.13	4.62	34	1.49	0.330
3.00	17	10/28/82 16:15	2.11	4.54	35	1.45	0.310
2.11	35	1/03/84 0:00	2.08	4.42	36	1.41	0.291
1.98	45	6/06/85 22:15	2.06	4.34	37	1.37	0.271
3.02	15	10/27/85 11:00	2.04	4.28	38	1.33	0.251
3.60	9	10/25/86 23:00	2.04	4.26	39	1.30	0.231
2.00	42	5/13/88 18:00	2.02	4.18	40	1.27	0.211
2.91	19	8/21/89 16:30	2.01	4.11	41	1.24	0.191
5.50	4	1/09/90 5:15	2.00	4.09	42	1.21	0.171
2.81	21	4/03/91 20:30	2.00	4.07	43	1.18	0.151
2.28	25	1/27/92 15:45	1.98	4.00	44	1.15	0.131
1.97	46	12/10/92 20:30	1.98	3.99	45	1.12	0.111
1.96	47	11/17/93 17:00	1.97	3.95	46	1.10	0.091
2.47	23	11/30/94 5:00	1.96	3.93	47	1.08	0.071
3.01	16	7/19/96 20:00	1.89	3.66	48	1.05	0.051
13.88	1	12/29/96 12:00	1.86	3.55	49	1.03	0.031
4.11	6	10/04/97 14:30	1.77	3.19	50	1.01	0.011
Computed Peaks			11.05	8.62		100.00	0.990
Computed Peaks			8.47	8.43		50.00	0.980
Computed Peaks			6.49	8.29		25.00	0.960
Computed Peaks			4.15	8.09		10.00	0.900
Computed Peaks			3.97	8.03		8.00	0.875
Computed Peaks			3.18	6.71		5.00	0.800
Computed Peaks			2.27	5.65		2.00	0.500
Computed Peaks			1.96	4.24		1.30	0.231